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AMERICAN INSTITUTE OF PHYSICS

335 East 45th Street
New York, NY 10017-3483

AIP REPORT

EDUCATION & EMPLOYMENT
STATISTICS DIVISION

Tel. 212-661-9404

by Susanne D. Ellis
and Patrick J. Mulvey

AIP Pub. No. R-211.22

April 1991

1989–90 SURVEY OF PHYSICS AND ASTRONOMY BACHELOR'S DEGREE RECIPIENTS

As we enter the last decade of the twentieth century, we look back at the 1980s to interpret some of the changes that have occurred. For example, between 1980 and 1990 the annual number of new physics bachelors rose 15%, from 4400 to 5100, with the entire increase taking place during the first half of the decade. Toward the end of the 1980s the economy began to experience a contraction; such a phenomenon may well have influenced the career plans of new graduates. Yet, an examination of the career choices, expressed by the new physics graduates, revealed a remarkably stable pattern during the entire decade. This finding is the result of surveying annually the members of successive graduating classes of physics as well as astronomy bachelors to determine the ratio between those who are interested in pursuing graduate studies with the group that chooses immediate employment.

Table I takes the physics bachelors and presents a more detailed version of their postbaccalaureate plans by dividing the potential graduate students into those who remain in physics, astronomy or a cross-disciplinary area, which represents a change in classification from earlier years, and those grouped under the heading of "other graduate study"; the latter group's interests could range anywhere from a physics-related discipline to a career in business or the humanities. The employment group is also divided into two subgroups in **Table I**, so as to separate the graduates who need to deal with the economic pressures of a changing job market, from those for whom the military service has commissions lined up or an offer of additional specialized training. A fifth group of graduates, though small, reports no immediate plans upon receiving their bachelor's degrees; they comprise only between two and five percent. To make all the percentages in **Table I** more meaningful, we present the total number of physics bachelors, by year, as the last row of data.

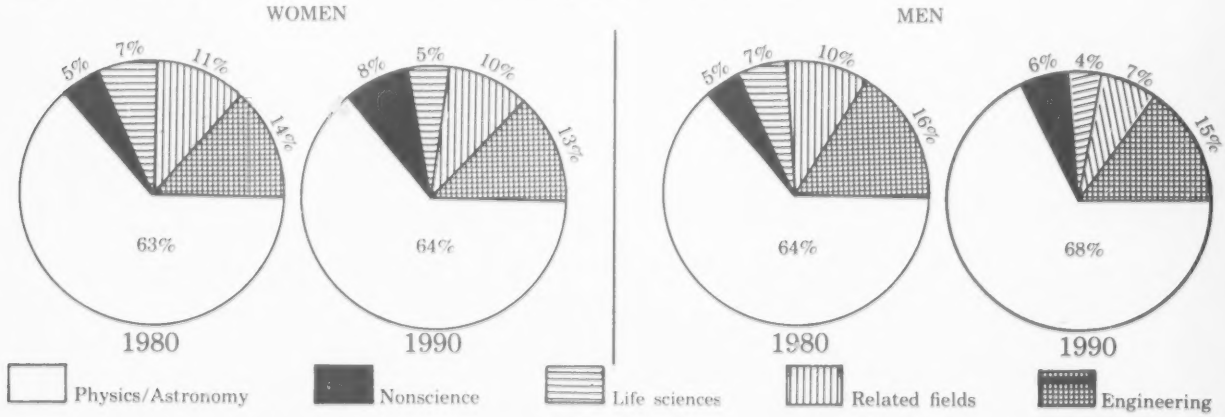
Table I. Postbaccalaureate plans of selected graduating classes of physics bachelors, 1980–1990.

Postbaccalaureate plans	1979–80	1984–85	1987–88	1988–89	1989–90
Physics/Astronomy graduate study*	32%	31%	32%	33%	34%
Other graduate study	22	19	19	18	19
Civilian employment	38	43	39	41	38
Military service	5	5	7	6	5
Undecided	3	2	3	2	4
Total number of physics bachelor's degrees	4440	5188	5152	5226	5111

**Earlier versions of this table included astronomy and cross-disciplinary areas of physics under "Other graduate study."*

Questions concerning the future potential supply of U.S. physicists could be answered by applying the percentages in the first row of **Table I** to the totals in its last row because the pool, from which many of the potential physicists are drawn, is the group that enters graduate physics programs without interruption. By carrying out an operation of this

Figure I. Subjects of graduate study chosen by physics bachelors.



Member Societies: The American Physical Society • Optical Society of America • Acoustical Society of America • The Society of Rheology • American Association of Physics Teachers
American Crystallographic Association • American Astronomical Society • American Association of Physicists in Medicine • American Vacuum Society • American Geophysical Union

type, we reveal a gradually rising trend that represents the "potential physicists." The fluctuating percentages shown for the group that chooses civilian employment each year may reflect some of the fiscal worries that existed at the end of the 1980s.

On the assumption that an undergraduate physics program that prepares a student for graduate school is different from one that is directed at the needs of local employers, we focus on the graduates of the former and examine what effect the events of the 1980s had on the career choices of men and women who emerged from similar undergraduate physics programs. Although the ratio of men to women is 4:1, those women who do decide to go to graduate school make choices that are similar to those made by men. **Figure I** elaborates on a number of these choices by showing that: 1. Irrespective of sex, approximately two thirds of the graduate-school-oriented bachelors planned to pursue the discipline they chose as undergraduates, namely physics or astronomy. 2. The events of an entire decade, during which the number of women doubled and the number of men increased by 40%, hardly changed the proportions in which physics bachelors chose their subjects of graduate study. 3. Of the group that intended the physics major to serve as a background for other graduate study, both men and women appeared to reduce their interest in the life sciences between 1980 and 1990. The disciplines that benefited from this re-distribution were the nonsciences chosen by women and physics/astronomy chosen by men. 4. The graduate discipline to which the largest number of physics bachelors transfer, is engineering; and it has attracted almost identical proportions of men and women for an entire decade.

Some definitions may be helpful in interpreting **Figure I**. For example, under "related fields" we included mathematics, the earth sciences and other physical sciences. The humanities, business administration, law and the social sciences were grouped under the heading of "nonscience." Physics/astronomy include the cross-disciplinary areas of each.

Whenever a new survey question receives a 90% response, one can assume that it had touched upon a favorite topic. The class of 1990 was asked "What prompted your interest in physics?" and the responses from half of the graduates were almost equally divided between a reference to their curiosity about nature and an expression of praise for the way physics was presented in high school. Many other reasons were cited, but space limitations in **Table II** allow us to present only the four most popular answers. A frequent answer, included under "The home environment", was: My father is a physicist.

Table II. Characteristics of new physics bachelors, 1989–90.

		Postbaccalaureate plans				
		Graduate study				
Characteristics		Physics/ Astronomy*	Other	Employment	Undecided	Total
Initial interest in physics	Curiosity about nature	24%	21%	27%	17%	25%
	Its presentation in high school	23	26	24	36	24
	Its presentation in college	13	12	8	15	11
	The home environment	10	8	7	10	8
Sex	Female	16%	16%	16%	23%	16%
	Male	84	84	84	77	84
Citizenship	U.S.	91%	91%	96%	96%	94%
	Foreign	9	9	4	4	6
Age	21 or younger	6%	5%	2%	3%	4%
	22	48	45	33	32	40
	23	23	27	26	28	25
	24–27	14	17	24	27	19
	28 or older	9	6	15	10	12
Minority groups**	U.S. blacks	2%	2%	3%	-	3%
	U.S. Hispanics	1	1	2	11%	1
	U.S. Asians	5	6	4	5	5
	Foreign minorities	5	7	3	3	3
Bachelors reporting a double major with:	Mathematics	17%	14%	8%	8%	12%
	Engineering	2	7	6	2	4
	Astronomy	4	2	2	2	3
Total number of bachelors**		1761	966	2180	204	5111
% distribution		34%	19%	43%	4%	100%
Number of respondents		963	528	1192	111	2794

**Earlier versions of this table included astronomy and cross-disciplinary areas of physics under "Other graduate study."*
***Data derived from the Survey of Enrollments and Degrees.*

Table III. A comparison between men and women among the 1989–90 physics bachelors and their high school physics backgrounds.

Type of high school physics		Women	Men	Total N	Total %
PSSC*		4%	5%	141	5%
Project physics		3	2	55	2
AP physics		18	19	510	19
General physics		63	63	1711	63
None		12	11	289	11
Total respondents	%	100%	100%		100%
	N	455	2251	2706	

**PSSC = Physical Science Study Committee.*

Table II divides the new physics bachelors into four groups according to their postbaccalaureate plan, thereby calling attention to differences in their characteristics. For example, the age distributions for the four groups differ from that shown in the "Total" column; only 35% of the employment-oriented bachelors are age 22 or younger compared with 50% and 54% of the two groups headed for graduate study. Similar differences are brought to light among those who graduate with a double major. Mathematics is the most commonly-chosen subject and 8% of the employment group made that choice. However, twice that proportion of the potential graduate students chose mathematics as their second major. Combining physics with engineering is a double major that appeals more to the employment-oriented graduates or to those who have been accepted by a graduate engineering school, than to the potential physicists. The proportion of foreign students among the physics bachelors remains small, though it too varies among the four groups.

Although only one quarter of the graduates in the class of 1990 attributed their initial interest in physics to its stimulating presentation in high school, almost 90% of the physics bachelors had enrolled in some type of high school physics course. **Table III** lists four types of physics courses and shows that women who intended to study physics in college were as likely as men to have begun their physics training in high school.

Table IV. Postbaccalaureate plans of U.S. and foreign minorities among the responding physics bachelors of the class of 1990.

Minorities	Postbaccalaureate plans: Graduate study Physics/ Astronomy*	Other	Empl.	Total %	Total N
U.S. blacks	27%	15%	58%	100%	55
U.S. Hispanics	36	13	51	100	39
U.S. Asians	38	25	37	100	133
Foreign minorities	44%	31%	25%	100%	121
All respondents	34%	19%	47%	100%	2794

**Earlier versions of this table included astronomy and cross-disciplinary areas of physics under "Other graduate study."*

Since the format of **Table II** tends to obscure the differences in the distribution of the postbaccalaureate plans among the minority groups, we single them out in **Table IV** to show how the career goals of blacks and Hispanics among the U.S. citizens are skewed toward employment, whereas the U.S. Asians traditionally choose graduate study over employment on a 2:1 basis. Foreign nationals, by and large, are in the United States on student visas that make them ineligible for regular employment.

Further differences emerge when we compare four U.S. minority groups with their foreign counterparts in **Table V**. The table also lists the Native American Indians and presents four background characteristics for each group. Noteworthy among the differences in characteristics among the minority groups is the consistently large proportion of women among U.S. blacks, while U.S. Orientals only recently began to increase their proportions of women to one that is above the average for all physics bachelors. The four-year colleges enroll 40% of all physics bachelors, yet a majority of U.S. blacks graduate from the smaller colleges.

Table V. Selected characteristics of minority physics bachelors, 1990.

		Minority group								
		Black		Native American Indian	Hispanic		Oriental		Other Asian	
		U.S.	Foreign		U.S.	Foreign	U.S.	Foreign	U.S.	Foreign
	Total	55	9	6	39	11	100	59	33	42
Sex	Female	15	–	1	6	2	26	9	9	5
	Male	40	9	5	33	9	74	50	24	37
Age	21 or younger	2	1	–	–	–	7	2	4	8
	22	28	1	–	9	3	43	15	10	3
	23	11	2	3	10	4	29	19	11	13
	24	2	–	–	6	1	6	7	4	5
	25–27	7	1	1	10	2	11	9	4	6
	28 or older	5	4	2	4	1	4	7	–	7
Region* of bach's inst.	Northeast	10	4	1	3	2	35	14	16	14
	Southeast	31	4	–	3	2	4	7	3	5
	Central & Mountain	13	–	4	20	4	21	14	5	16
	Pacific	1	1	1	13	3	40	24	9	7
Type of bach's inst.	PhD-granting	13	6	4	23	7	77	40	19	20
	MS-granting	7	1	1	5	–	4	3	3	4
	BS/BA-granting	35	2	1	11	4	19	16	11	18
	Public	28	4	5	30	6	56	34	17	21
	Private	27	5	1	9	5	44	25	16	21

**Regions: Northeast = New England, Middle Atlantic; Southeast = South Atlantic, East South Central; Central = East North Central, West North Central, West South Central.*

Table VI. Sources of anticipated support for first-year graduate study†, 1988 to 1990.

Sources of support	Students planning: Physics/Astronomy graduate study**			Other graduate study		
	1988	1989	1990	1988	1989	1990
Teaching assistantship	47%	48%	45%	14%	15%	15%
Research assistantship	12	12	14	15	16	15
Fellowship	16	18	21	13	17	16
Family, savings, loan	4	4	4	24	27	30
Part-time employment	6	4	6	22	16	17
Other	1	1	1	3	2	1
Multiple: TA/RA	6	4	4	5	3	3
Multiple: TA/Fellowship	6	6	4	3	2	1
Multiple: TA/Family, savings, loan	2	3	1	1	2	2
	100%	100%	100%	100%	100%	100%
Graduate study status: full-time	93%	93%	95%	86%	82%	85%
Graduate study status: part-time	7	7	5	14	18	15
Total number of full-time students	1650	1725	1762	925	940	966

The information was reported for September of each academic year.
**Earlier versions of this table included astronomy and cross-disciplinary areas of physics under "Other graduate study."*

The decision to apply to graduate schools is not only based on motivation but also in part on the available sources of support. **Table VI** illustrates a compelling reason for physics bachelors to remain in physics, astronomy or a cross-disciplinary area of those sciences by showing how large a proportion of graduates were offered teaching assistantships. By contrast, only 15% of the group that entered "other graduate study" was assured of teaching assistantships. Another major difference comes to light when we compare the proportion of bachelors in each group that needs to resort to its own funds or seek part-time employment off campus; only 8% - 10% of the potential physicists reported these sources of support in contrast to almost half of the nonphysics graduate students. By presenting these data for the three most recent graduating classes we intend to show that this funding scenario has not changed.

One source of support conspicuously omitted from the primary listing in **Table VI** is full-time employment. Each year, between 200 and 300 physics bachelors who had accepted full-time employment pursued graduate studies on a part-time basis and are presented in the lower portion of **Table VI**.

Irrespective of a changing economy or the promising careers outlined by graduate schools, an almost constant 40% of the new physics bachelors each year choose immediate employment; hence an analysis of the demand for so large a group is an important part of this survey. One way of accomplishing that is to ask each employment-oriented graduate for the number of job offers he or she received. **Table VII** presents a scale of no offers, one offer and multiple offers for the most recent three years and adds 1985, 1980 and 1975 for purposes of comparison. The first category, "zero job offers", may require some clarification so as not to mistake it for a general unemployment rate; it refers to the period immediately after graduation when many bachelors have allotted insufficient time to explore the job market. Thus the demand has hardly changed since 1988 but indicates a gradual decline when compared with 1985 and 1980 because far fewer graduates are now reporting multiple offers to choose from.

Figure II elaborates on the postbaccalaureate plans of each of the three major groups, but gives special attention to the group that described its employment plans. Since there were almost 1200 respondents in this group and their commitments varied considerably, we created three subgroups. The physics bachelors who reported stable employment comprised a majority (56%). The second group that described itself as "employed and seeking" held positions that either lacked permanence or were holdovers from their student days. The members of the remaining group were still actively seeking suitable employment when they responded to this survey.

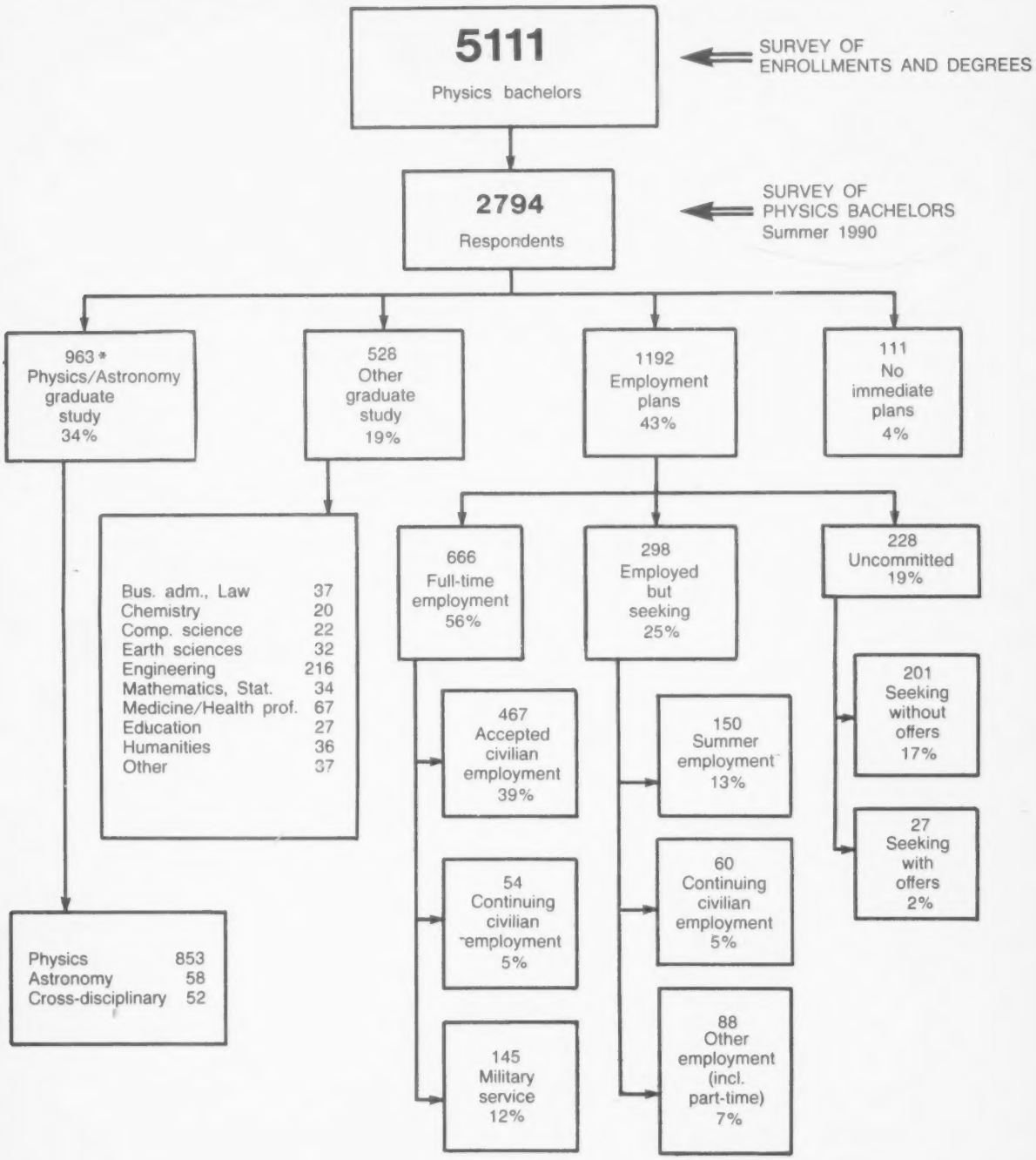
In comparing the data in **Figure II** with those of the previous year, it appears that the proportion of bachelors who were "employed but seeking" increased significantly in one year; but this is not the case. In the class of 1990 we showed 60 graduates from the group of 114 that continues its civilian employment and separated them because they were seeking more appropriate positions. Previously they had simply been identified as continuing employment.

Table VII. Changes in employment outlook for new physics bachelors, 1975 to 1990.

Number of job offers at graduation	Summer 1975	Summer 1980	Summer 1985	Summer 1988	Summer 1989	Summer 1990
0	17%	10%	14%	16%	16%	17%
1*	56	50	59	67	68	68
2 or more	27	40	27	17	16	15

**Bachelors who enter the military are included here.*

Figure II. Postbaccalaureate plans of physics bachelors of the class of 1990.



**Includes astronomy bachelors from Figure III who reported a double major with physics.*

Table VIII. Initial U.S. or foreign employment of physics bachelors, 1980 to 1990.

Type of employer*	Percentage of employed bachelors 1980–81	1984–85	1987–88	1988–89	1989–90
Industry { manufacture	40%	33%	29%	29%	28%
Industry { service	22	18	20	19	18
High school	2	5	5	5	8
College or university	4	4	4	5	5
Government { civilian	7	14	9	12	14
Government { military	21	23	30	27	25
Other	4	3	3	3	2
Total	100%	100%	100%	100%	100%

**Re-definitions of categories make the data in this table not directly comparable to those in earlier versions.*

Although the new physics bachelors comprise a very small fraction of the technical labor force, the positions they accepted for their initial employment reflected the gradually declining technical manufacturing industry during the 1980s. **Table VIII** lists the major types of employers chosen by the new physics bachelors of the three most recent graduating classes and compares this trend with comparable data from 1984-85 and 1980-81. Due to a re-definition of "service industry," this table is not directly comparable to earlier published versions.

For all employers combined, the median starting salary reported by physics bachelors from the class of 1990, increased by 6% over that of the previous year. It is well known that salaries vary greatly for different types of employers; to narrow that range, we presented monthly salaries in **Table IX**. On that basis we found that the median salary paid by service industries does not differ greatly from that paid by high schools. It is therefore important to keep in mind that high school teachers receive only nine or ten of the monthly installments each year while industrial employees are paid those monthly salaries twelve times each year. A notable change from the previous year is that the proportion of women who accepted high school teaching positions doubled.

Two factors contribute to a higher median salary for women than men: A smaller proportion of women than men are in the military, and industrial manufacturers continue to pay higher salaries to women than men.

The tables that deal with initial employment, by definition, exclude those bachelors who did not seek employment in 1990 because they had decided to remain with the employers for whom they worked before receiving their bachelor's degrees. However, their types of employers and work activities are similar to those of the newly-employed physics bachelors, hence we present **Table X** which combines the two groups. This table relates eight work activities to the five major types of employers and indicates to what extent the graduates are using their physics training.

Table IX. Starting salaries of physics bachelors in the U.S., class of 1990.

Type of employer	Men (417 reported salaries) Dist. by employer	Men Median monthly salary	Women (81 reported salaries) Dist. by employer	Women Median monthly salary	Total (498 reported salaries) Dist. by employer	Total Median monthly salary
Industry { manufacture	28%	$2420	25%	$2510	27%	$2475
Industry { service	17	2170	23	2000	18	2165
High school*	6	2220	14	2100	8	2110
College or university	5	1780	5	**	5	1720
Government { civilian	10	2190	19	2100	12	2190
Government { military	29	1830	7	1750	26	1830
Fed. Fund. Res. Ctr.	3	2680	2	**	2	2580
Nonprofit organization	2	1875	5	1770	2	1875
Total	100%	$2080	100%	$2110	100%	$2085

**The high school salaries were calculated by dividing the annual salary by the number of months in the school year.*
***Insufficient data.*

Table X. Full-time employment* of new physics bachelors in the U.S., class of 1990.

Work activity		Type of employer: Industry manufacture	Industry service	High school	Government civilian	Government military	Coll. univ.	Nonprf. org.	Total N	Total %
Teaching		–	–	42	5	4	3	3	57	8%
Research & development		64	9	–	35	9	29	4	150	21
Development & design		83	6	–	16	9	–	–	114	16
Programming		30	40	–	18	4	6	4	102	14
Skilled labor		15	32	3	16	5	7	2	80	11
Specialized training**		8	11	–	9	99	–	1	128	18
Marketing		8	7	–	–	–	–	–	15	2
Other professional work		3	17	–	7	15	3	1	46	7
Other		2	18	–	–	–	–	–	20	3
Total	N	213	140	45	106	145	48	15	712	
	%	30	20	6	15	20	7	2		100%
Use of physics training	Extensive	38%	13%	61%	42%	38%	61%	36%		37%
	Little	49	40	29	47	52	31	43		45
	None	13	47	10	11	10	8	21		18

**The employment of these 712 graduates includes both newly accepted positions as well as those in which graduates are continuing. Excluded are graduates in temporary, summer and foreign employment.*

***Training paid for by employer includes pilot/navigator training by the military.*

ASTRONOMY

To facilitate comparisons between new astronomy and physics bachelors, we arranged the information reported by them in a similar format. From the Enrollments and Degrees survey we learned that 55 institutions offer an astronomy major at the undergraduate level and granted 176 bachelor's degrees in 1989-90. There were 148 graduates who contributed descriptions of their postbaccalaureate plans to this survey. Thus 46% of the astronomy graduates, compared with only 34% of the physics graduates remained in astronomy or physics by entering those graduate programs. Six

Table XI. Characteristics of astronomy bachelors, 1989–90.

Characteristics		Postbaccalaureate plans: Graduate study Astronomy/Physics** N	Graduate study Other N	Employment N	Undecided N	Total %
Type of degree	Bachelor of Science	51	11	31	4	66%
	Bachelor of Arts	17	9	24	1	34
Sex	Female	18	7	15	3	29%
	Male	50	13	40	2	71
Citizenship	U.S.	64	19	53	4	95%
	Foreign	4	1	2	1	5
Type of high school physics	PSSC	5	4	4	–	9%
	Project physics	–	–	3	–	2
	AP physics	7	5	12	–	16
	General physics	49	11	32	5	66
	None	7	–	4	–	7
Age	21	3	2	4	–	6%
	22	30	9	20	1	41
	23	19	4	18	1	28
	24	6	1	3	1	7
	25 or older	10	4	10	2	18
Type of bachelor's institution	PhD-granting	55	13	49	4	82%
	MS-granting	–	–	1	–	1
	BS/BA-granting	13	7	5	1	17
	Public	55	15	34	4	73%
	Private	13	5	21	1	27
Total respondents		68	20	55	5	148
Total number of astronomy bachelors		80	25	65	6	176

***Earlier versions of this table included physics under "Other graduate study."*

characteristics of the astronomy graduates are related to the postbaccalaureate plans in **Table XI**. Continuing trends indicate a large proportion of women and the fact that three quarters of them were enrolled at a PhD-granting university.

Table XII compares the class of 1990 with two earlier classes, five and ten years ago, to show a recent shift in postbaccalaureate plans away from employment and toward graduate study.

Figure III elaborates on each of those postbaccalaureate plans of the astronomy graduates by indicating how well supported the graduate astronomy/physics students are, what other subjects of study were chosen and how successful the employment-oriented graduates were in accepting positions. It should be stated that the 148 respondents include 32 physics bachelors who had a double major with astronomy.

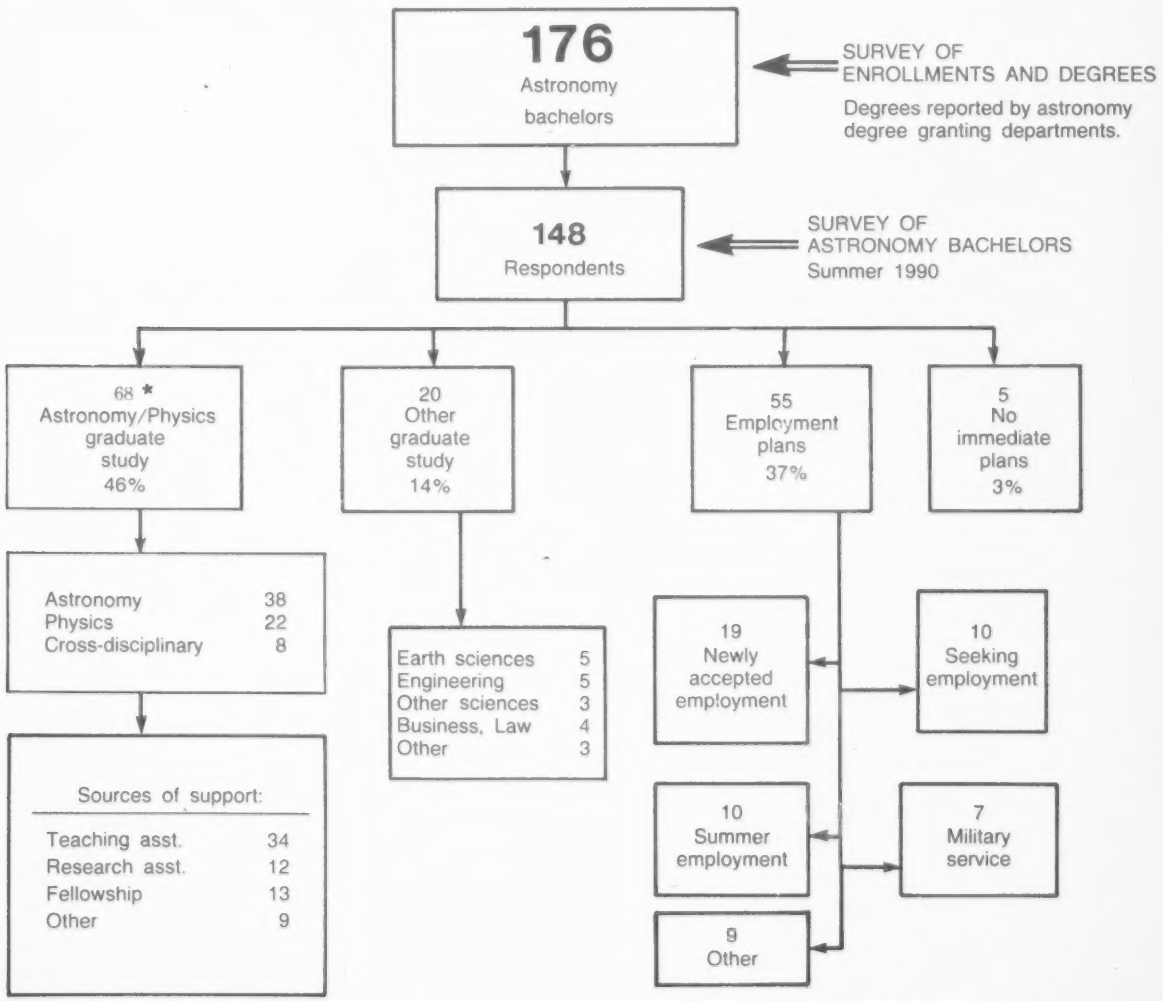
This report was prepared with the help of Thomas N. Stovall.

Table XII. Postbaccalaureate plans of selected graduating classes of astronomy bachelors, 1980 to 1990.

Postbaccalaureate plans	1979–80	1984–85	1989–90
Astronomy/Physics graduate study*	42%	42%	46%
Other graduate study	10	10	14
Employment	43	45	37
Undecided	5	3	3
Total number of astronomy bachelors	165	145	176

**Earlier versions of this table included physics under "Other graduate study."*

Figure III. Postbaccalaureate plans of astronomy bachelors of the class of 1990.



**Includes 32 physics bachelors from Figure II who reported a double major with astronomy.*